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APPENDIX 4

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GEOLOGY AND DRILLING HISTORY

OF

LANIPUNA #1/SIDETRACK,

TOKYO LANDS PROSPECT,

HAWAII

for

BARNWELL INDUSTRIES, INC.

NEW YORK, NEW YORK

by

GeothermEx, Inc.
Richmond, California

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November 1983

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CONCLUSIONS

1. Lanipuna #1/Sidetrack (ST) is a directional hole which departs from the Lanipuna #1 geothermal exploration well at a depth of 3,570 feet in a direction of N 20° E. At total depth (6,271 feet) the hole is located 844 feet north and 344 feet east of the wellhead.

2. The sidetracked hole penetrated a uniform sequence of basalt flows without discernable lithologic characteristics to distinguish the geology from that of the original hole.

3. A positive conductive gradient of 9°F/100 feet from a depth of 4,000 feet to 5,100 feet, near isothermal conditions from 5,100 feet to 5,400 feet and a sharp reversal from 5,400 feet to about 6,200 feet and a positive conductive gradient from 6,200 feet to total depth (6,271 feet). An average conductive gradient of -9°F/100 feet was observed in temperature surveys. A maximum temperature of 429°F was recorded at a depth of 5,400 feet.

4. A comparison of penetration rates and of relative abundances of alteration minerals plotted against depth between Lanipuna #1 and the sidetrack reveals a number of horizons which correlate closely and support a model of near horizontal or shallow dipping layers to the southwest of basalt flows. The tendency of Lanipuna #1 to drift northeastward supports evidence of a slight dip to the southwest, since most holes naturally deviate in an updip direction.

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RECOMMENDATIONS

1. Perform a detailed thin section study of cuttings from Ashida #1, Lanipuna #1, Lanipuna #1/ST and HGP-A to confirm the existence of metamorphic facies and their relationship to formation temperatures. It it worthwhile to answer the question of whether the alteration mineral assemblages of rocks from the bottom of the sidetrack are in equilibrium with measured temperatures or indicate equilibration with higher temperatures such as those measured at the same depth in Lanipuna #1.

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INTRODUCTION

The Lanipuna #1/ST is a directionally drilled hole which departs from the Lanipuna #1 geothermal exploration well at a depth of 3,570 feet in a direction of N 20 E. The total vertical depth of the directionally drilled hole is 6,271 feet. The bottom of the hole is located 844 feet north and 344 feet east of the drillsite.

The drillsite is located near the center of the Kilauea East rift, approximately 1,800 feet SSE of H.G.P.-A. Elevation at the wellsite is 600 feet above mean sea level.

Access to the drillsite is by a 1/4-mile cinder road which joins Hawaii County Highway 132 approximately 1,000 feet south of H.G.P.-A.

The drilling rig was moved onto the location on May 10, 1983. Drilling operations began on May 17 and concluded on June 19. During the course of drilling operations there were no major interruptions. One minor loss of drilling fluid to the hole was recorded while drilling at a depth of 4,250 feet. About 20 barrels of mud were lost to the hole.

Samples of drill cuttings show that the hole penetrated a uniform section of submarine basalt flows with no significant zones of permeability. A maximum temperature of 429°F was recorded at a depth of 5,300 feet.

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DRILLING HISTORY

Phase 1: Preparations to sidetrack the hole

On May 10, 1983 the drill rig was moved onto location, and rigged for service. The following day the cased portion of Lanipuna #1 was gyro-surveyed for drift and drift direction.

On Thursday, May 12, the 7" liner was cut at a depth of 5,035 feet and removed from the hole. A cement plug was pumped into the hole at 3,763 feet on Friday. The plug set up and hardened during the weekend.

On Monday, May 16, drill pipe was run into the hole to a depth of 3,495 feet where the top of the cement plug obstructed the hole. At this point the pipe rams and the Hydril bag-type preventers were each pressure-tested with 600 psi for 15 minutes. Then, the cement plug was drilled to a depth of 3,570 feet using water as a drilling fluid. At 3,570 feet the hole was conditioned with a light mud/gel drilling fluid.

Phase 2: Directional drilling

The program of building the correct angle and direction for the new hole was designed and supervised by Mr. Dave Dimitt, consultant, from Santa Rosa, California. The plan called for initial buildup of 3°/100 feet in a northerly direction, terminating in a hole angle of 20° from vertical. It was hoped that the natural tendency of the formations to pull the hole in a NE direction as observed in Lanipuna #1 would orient the sidetrack in a NNE direction. The plan worked well.

On Tuesday, May 17, an 8-3/4" bit, a 2° sub, a Dynadrill and a monel collar comprised the directional drilling assembly used to kick off the new hole at a depth of 3,570 feet. Dynadrilling with frequent breaks to measure the angle buildup continued throughout the week. On Saturday, May 21, the new hole had measured depth of 3,920 feet and a terminal angle of nearly 9°.

The following week, hole angle was increased by Dynadrilling and by Saturday, May 28, the measured hole depth had reached 4,451 feet. Hole angle (or drift) slightly exceeded 20°, and drift direction was approximately NNE.

Phase 3: Drilling an 8-3/4" hole

On Tuesday, June 1, drilling resumed. A new drilling assembly, consisting of an 8-3/4" button bit, a near bit blade-stabilizer, a monel

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collar, a string stabilizer and 16 6- 3/4" drill collars was run into the hole. This assembly was designed to pack the hole and lock the drift of the hole. Small changes in hole angle were controlled by moving the string stabilizer up or down the drillstring the length of one drill pipe. In this manner, the 8-3/4" hole was drilled to total depth without incident.

On Saturday, June 4, measured depth was 5,078 feet. The terminal drift angle was 26°, and drift direction was N 20° E. By Saturday, June 11, the hole had been deepened to 5,967 feet (measured depth). Drift angle was holding steady at 24°, and drift direction was locked onto N 20° E.

On Saturday, June 18, torque increased, and the penetration rate dropped abruptly. Drilling was terminated at a measured depth of 6,465 feet (6,271 feet, true vertical depth). Later, it was learned that the drill bit had lost its ball bearings and started drilling an undersized hole. The increased pressure on the blade stabilizer as it opened the hole to proper gauge caused the rise in drilling torque.

Phase 4: Well testing

On Monday, June 20, mud was displaced from the hole in stages with water. The hole was monitored for temperature buildup and changes in fluid level until July 19 when the hole was unloaded with compressed air to a depth of 2,000 feet in an unsuccessful attempt to initiate a flow from the well. During continuous unloading from July 19 to July 22, a maximum of about 25 gpm of fluid entry was observed. Temperature measurements were made with the GRC/Kuster Tool (Appendix B).

On Saturday, July 23, the hole was filled to the surface with fresh water and kept full, in an attempt to rock the well hydrostatically and induce flow. On Wednesday, July 27, the hole was again unloaded to a depth in excess of 3,000 feet. Again, inflow was observed at about 30 gpm. A water sample was collected for analysis. A temperature measurement on Saturday, July 30 showed that the well had re-established the profile that it had prior to attempted stimulation.

On or about August 1 the well was completed with a plug and bleed valve.

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DRILLING FLUIDS

The weights of the mud/gel drilling fluid increased gradually as the hole was deepened, from 8.4 lbs/gal (water = 8.33 lbs/gal) on May 18 to 9.0 lbs/gal on June 9 (total depth = 5,498 feet). Mud weight was held at a constant 9.0 lbs/gal while drilling the bottom 1,000 feet of hole.

Mud viscosity was somewhat more erratic, fluctuating between 33 and 39 seconds. Viscosities tended to be higher as the hole was deepened.

Water loss was kept below 10 cc's while drilling the hole. Solids were never a problem due to the types of formations drilled and constant use of the desilters. The pH was kept above 10.5 at all times.

Twenty barrels of mud/gel drilling fluid were lost during a drilling break at a true vertical depth of 4,250 feet. There were no further losses during drilling operations.

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PENETRATION RATE

Penetration rates fluctuated from less than 5 feet/hour to greater than 35 feet/hour during the drilling of Lanipuna #1/ST. Sudden increases in the penetration rate (called drilling breaks) occur at depths of 4,250 feet, 4,540 feet, 4,700 feet, 6,010 feet, 6,070 feet and 6,180 feet. Smaller breaks also occurred at depths of 4,040 feet, 4,400 feet, 4,980 feet, 5,160 feet and 5,760 feet.

The wellbore lithology shows that most of these drilling breaks occur as the drill bit penetrates zones of intense alteration. A comparison of drilling breaks recorded in Lanipuna #1 and the sidetrack is discussed later in this report.

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FLUID LEVELS

On June 21, 1983 the mud/gel drilling fluid was displaced from the hole with water. As the drill pipe was removed from the hole, water was not added to make up for the lost volume of drill pipe. With the drill pipe out of the hole, the fluid level was measured at 492 feet depth. The subsequent drop in the fluid level from June 22 to June 24 to a depth of 648 feet (RKB) indicates equilibration of wellbore fluids with a permeable formation at near hydrostatic conditions. As the well fluid heated up, fluid density decreased and the fluid level began to rise slowly in the hole. By the time the hole was unloaded on July 19, near stillstand occurred with the water level about 10 feet above mean sea level.

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TEMPERATURE REGIME

Over 20 temperature surveys were conducted during the drilling and after the completion of Lanipuna #1/ST (Appendix B). From 4,400 feet (true vertical depth) to 5,100 feet formation temperatures conductively rise at an average of 9°F/100 feet. From 5,100 feet to 5,300 feet temperatures are nearly isothermal, indicating slightly permeable rocks within this interval. Below 5,300 feet formation temperatures decrease at about 9°/100 feet. From a depth of 6,200 feet to total depth of 6,271 feet the gradient decreases very little suggesting that an isothermal to positive temperature profile exists at greater depth.

Temperature surveys recorded during production testing indicated zones of permeability near 5,200 feet and below 6,000 feet.

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LITHOLOGY

Samples of drill cuttings were collected at the shaker table for every 20 feet of drill hole. Corrections for lag time, and true vertical depth were applied to each sample.

Samples were washed and dried, then examined with a binocular microscope, and described in detail. Appendix A contains these detailed descriptions of drill cuttings.

The entire drilled section, except for two thin layers of clay encountered at depths of 3,655 feet and 5,691 feet, is comprised of submarine basalt flows with one basic mineral assemblage: plagioclase, clinopyroxene, $\pm$ olivine, glass and opaque minerals.

Sample descriptions emphasize variations in the degree of crystallinity and to a lesser extent, phenocryst content, as the best guide to the igneous stratigraphy. Samples of very glassy rock (Type C) are assumed to be derived from the quenched exterior of these submarine flows and possibly from thin basalt dikes. Fine crystalline hypidiomorphic-granular basalts (Type D) are composed of equidimensional crystals of pyroxene and plagioclase which form by the accumulation of settling crystals at the bottom of stationary flows. Most samples exhibit a cryptocrystalline or aphanitic matrix (Type B) derived from the bulk material of individual flows.

Sample descriptions also report the type and extent of alteration as a measure of rock permeability and porosity and formation temperature. The relative abundance of the various alteration minerals are estimated inAppendix A.

The presence of a green to blue-green wax-like substance forming nodules or coating fracture surfaces was detected at several depths within the sidetrack. Nodules are composed of either chlorite or chlorophaetie and clay with pyrite and epidote as accessory minerals. The nodules probably formed by accretion in vesicles. Detection of nodules signifies a sharp increase in vesicularity and therefore, porosity, within a lithologic section of predominantly nonvesicular basalts.

The alteration of plagioclase phenocrysts and groundmass laths to a chalky white material comprised of montmorillonite and possibly sausserite is a common occurrence within the drilled section and is too prevalent to be a useful tool in the detection of permeable zones.

Pyrite is another alteration mineral which is virtually ubiquitous. The mineral occurs as minute disseminations and as an accessory mineral within chlorite-filled vesicles or veins of quartz. Despite the relatively

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high background abundance of pyrite, anomalously large concentrations of the mineral were found to co-exist with concentrations of nodular chlorite or vein quartz within the more permeable and porous horizons of the drilled section.

Veins of a massive white mineral which is easily scratched were identified at three points around a depth of 4,200 feet. The mineral is tentatively identified as anhydrite. It is associated with concentrations of pyrite and quartz as well as nodular chlorite.

Silica, occurring as blue milky chalcedony, terminated vapor phase quartz and massive vein quartz, is the most useful tool in the detection of permeable and/or porous horizons within the drilled section. Chalcedony was observed only at a depth of 3,720 feet within the sidetrack. Clusters of vapor phase quartz were frequently observed within the interval from 3,800 feet to 4,260 feet and 5,790 feet to 6,060 feet. These clusters apparently formed in vesicles or fractures, thereby demonstrating some porosity, although the implications of permeability are uncertain.

Massive vein quartz is the most common form of silica. A background of low concentrations was observed throughout the sidetrack. The largest concentrations occur between 3,800 to 4,000 feet and at depths of 4,260 feet and 5,100 feet. Evidence of a pervasive but very low fracture permeability for the overall section is recorded within the sample descriptions as the trace amounts of massive quartz in thin veins (less than 1 mm wide) observed in most samples. The large accumulations of quartz correlate with concentrations of nodular chlorite and/or vapor phase quartz in the porous horizons of the lithologic section.

The occurrence of chlorite within the groundmass as crypto-crystalline material is of no clear-cut significance, whether detected by a green sample color or as larger crystal splays clearly visible beneath the binocular microscope. Samples which show no trace of chlorite alteration must represent exceedingly impermeable rocks. The apparent transition from cryptocrystalline to phaneritic chlorite has been observed before in other holes and may be related to either a change in the particular thermal regime or an increase in effective porosity.

Porous zones within the drilled sections are best indicated by concentrations of chlorite nodules and clusters of vapor phase quartz. Besides mud losses while drilling, permeability is best shown by concentrations of vein material, particularly quartz, and also pyrite, anhydrite(?) and chlorite. Drilling breaks usually reflect some change in lithology, and they appear to correlate well with porosity.

The interval from 3,800 to 4,000 feet depth is characterized by a moderately high penetration rate and large concentrations of chlorite

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nodules, pyrite, vapor phase quartz, massive quartz and cryptocrystalline chlorite within the groundmass, evidence of anomalous porosity and permeability.

A drilling break at a depth of 4,050 feet was also marked with a concentration of chlorite nodules and vapor phase quartz, indicating a vesicular flow. A smaller drilling break at 4,140 feet is associated with numerous veins of pyrite and anhydrite as well as vapor phase quartz.

At a depth of 4,250 feet a sharp increase in the penetration rate corresponded with the loss of 20 barrels of drilling mud. Drill cuttings from that depth contain an abundance of chlorite nodules, pyrite and quartz veins and pervasive groundmass alteration to chlorite, strong evidences of anomalously high porosity and permeability.

The next large drilling break at a depth of 4,540 feet was associated with abundant veins of pyrite, a few veins of massive quartz and abundant groundmass chlorie. Smaller breaks at 4,580 feet, 4,700 feet and 4,750 feet are also associated with slightly higher than normal amounts of vein quartz.

The wide break at 4,980 feet reflects a thick interval containing chlorite nodules with accessory pyrite.

Temperature surveys that record nearly recording near isothermal conditions between 5,100 and 5,300 feet indicate slight permeability. A narrow break at 5,100 feet is marked by an abundance of quartz veins and pervasive groundmass alteration to chlorite. Another break at 5,160 feet was associated with a small but anomalous increase in quartz veins, and a triple-peak break, centered at 5,300 feet, was associated with an abundance of pyrite veins, but no quartz was observed.

Beneath 5,300 feet the occurrence of nodular chlorite is more frequent and drilling breaks appear to coincide with the more vesicular horizons, a singular exception occurs at a depth of 6,000 feet, where a break is associated with an abundance of pyrite and a minor quantity of quartz veins.

Temperature surveys conducted during production tests demonstrated a small flow into the hole from a low permeable zone located below a depth of 6,000 feet.

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LANIPUNA #1 AND LANIPUNA #1/SIDETRACK: A COMPARISON

Penetration Rates

Penetration rate is a function of many variables, including lithology, type of bit, condition of bit, weight on the bit, revolutions/minute of the bit and properties of the drilling mud. Drilling rates are not comparable between the two holes above a depth of 4,200 feet because that part of the sidetracked hole was drilled with a Dyna drill, and the original hole was drilled by conventional means. Therefore, the conspicuous drilling break recorded in Lanipuna #1 at a depth of 3,780 feet does not appear in the sidetrack, although at that depth the holes are barely 20 feet apart.

Several other drilling breaks correlate precisely between the two holes. The most conspicuous occur at depths of 4,250 feet and 4,540 feet.

Below a depth of 5,000 feet there are no perfect matches. Several drilling breaks in Lanipuna #1 (5,020 feet, 5,200 feet, 5,780 feet and 6,220 feet) are preceded at slightly shallower depths by drilling breaks in the sidetracked hole (4,980 feet, 5,160 feet, 5,760 feet and 6,180 feet).

The large drilling break recorded at a depth of 6,240 feet in Lanipuna #1 was not repeated in the sidetrack. This is probably due to the condition of the bit which apparently lost a bearing at a depth of 6,230 feet when the penetration rate dropped suddenly and the drilling torque increased dramatically.

Mud Temperatures

Mud temperatures for both Lanipuna and the sidetracked hole were controlled by use of the cooling tower and the desilters.

Temperature Regimes

Formation temperatures from both holes were estimated from bottom-hole buildup measurements logarithmically expounded to infinity and from maximum recorded temperatures in permeable zones after some flow into the wellbore had been initiated. These temperatures were used as a base in curve matching temperature profiles for each well. Distances between the two holes are measured distances which define a slightly curved cross-sectional surface (as opposed to projecting both hole locations to a single, flat plane of reference).

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Several features are significant. There are two sharp increases in the conductive temperature gradient of Lanipuna #1, one is above the isothermal zone which begins at a depth of 5,800 feet and a second is near the bottom of the hole. Overall, the gradient is positive for the entire depth of the hole.

Recorded temperatures from the sidetrack reveal a different thermal profile. The conductive gradient increases slightly to 9°F/100 feet just before the hole enters an isothermal zone at a depth of 5,200 feet. Below 5,500 feet the gradient is negative to about 6,200 feet depth, at about -9°F/100 feet. However, near the bottom, the positive conductive gradient recurs at about 5°/100 feet.

The sharp increase in the conductive gradient at the bottom of Lanipuna #1 could indicate another isothermal zone at no great distance from the bottom of the hole.

Lithology

Appendix A contains the lithology of the sidetrack hole. Both the original hole and the sidetrack are comprised of virtually identical igneous lithologies. The sections are characterized by monotonously similar descriptions with no distinct features attributable to the igneous stratigraphy which might simplify a correlation.

As discussed earlier, the presence of a green wax-like material (chlorophaeite, clay, and/or chlorite) forming nodules within the rock emphasizes the relatively high initial porosity of a vesicular basalt flow within a sequence of predominantly non-vesicular rocks. The plot of the occurrence of nodules (i.e., vesicularity) for Lanipuna #1 is also a plot of original porosity with some stratigraphic implications. For Lanipuna #1 the frequency of occurrence is high from the surface to a depth of 3,420 feet. Below 3,420 feet, the appearances of chlorite nodules are sporadic except for one thick section from 6,060 feet to 6,300 feet.

A similar frequency of occurrence is preserved in sample descriptions of the sidetracked hole with sporadic observations of chlorite nodules from 3,800 feet to 6,060 feet, and more frequent occurrences from 6,060 to total depth (6,271 feet).

Fibrous splays of a soft white mineral, tentatively identified as zeolite, were encountered at shallow depths above 3,000 feet and within the interval from 7,600 to 8,000 feet in Lanipuna #1. No zeolite was identified within the sidetracked hole.

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Similarly, occurrences of hematite in Lanipuna #1 were restricted to intervals above or below the drilled section for the sidetrack (3,570 to 6,271 feet). No hematite was recognized in drill samples from the sidetrack.

The alteration of plagioclase phenocrysts and groundmass laths to a white chalky substance composed of montmorillonite, plus or minus sausserite, is a common, yet sporadic, occurrence in both holes and of no aid in stratigraphic correlations or in the detection of permeable and porous horizons.

Pyrite is another alteration minerals, which, like clay, is ubiquitous; unusually large concentrations of the mineral correlate with large concentrations of nodular chlorite, vapor phase quartz, and/or massive vein quartz as well as with drilling breaks.

Significant concentrations of pyrite appear to correlate between wells at depths of 3,900 feet, 4,100 feet, 4,250 feet, 4,640 feet, 5,040 feet, 5,300 feet, 5,820 feet, 5,990 feet; 6,100 feet and 6,200 feet. At these depths the unusual concentrations of pyrite in both holes underscore correlations of other minerals and drilling breaks.

The appearance of white gypsum or anhydrite and milky, blue chalcedony in the drill cuttings from either hole is a rare event and of no use in correlation.

A comparison of the frequency of occurrence and relative abundances of the clusters of both terminated vapor phase quartz and the massive interlocking crystals of quartz in thin veins shows a marked contrast. In Lanipuna #1 clusters of terminated quartz were frequently observed, but the thin veins of massive quartz were rare. In the sidetrack there were very few observations of terminated quartz and far more of the massive vein quartz.

Correlations of large concentrations of either form of silica occur at many depths. Large quantities of vapor phase quartz in Lanipuna #1 and both vapor phase quartz and massive vein quartz in the sidetrack were spotted at 3,850 feet. This section was drilled rapidly in the original hole and penetrated with the Dyna drill in the sidetrack.

At a depth of 4,050 feet vapor phase quartz exists in both holes. This was a depth of inflow into the original hole during production testing.

At 4,630 feet vapor phase quartz occurs in anomalously large amounts in both holes and also correlate with high concentrations of pyrite.

At 5,090 feet there are trace amounts of vapor phase quartz in Lanipuna #1 and large amounts of massive vein quartz in the sidetrack which correspond to small drilling breaks.

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Again at 5,790 feet, minor amounts of vapor phase quartz correspond with drilling breaks in both holes.

Finally, at 6,060 feet anomalous quantities of vapor phase quartz correspond with large drilling breaks in both holes.

Chlorite forms crypotcrystalline intergrowths and larger phaneritic crystals within the altered groundmasses of the basalt flows. Crypotocrystalline chlorite is probably ubiquitous to the basalt section; it has been recognized in all thin sections from both the Ashida well and Lanipuna #1, although the amounts of chlorite in each sample varies considerably, ranging from barely preceptible to pervasive alteration. The difficulty in assigning a volumetric percentage to chlorite content is too great without the aid of a thin section. Therefore, chlorite as studied is not a suitable mineral to use either for stratigraphic correlation or for a measure of permeability.

Several minerals, including biotite, calcite and epidote, were noted in the binocular descriptions of samples of Lanipuna #1 and later verified in thin section; these minerals were not identified in the drill cuttings from the sidetracked hole.

The biotite occurs within an isothermal zone between 6,060 feet and 6,300 feet. Its formation is probably related to the presence of a potassium-rich fluid.

Calcite is normally associated with the cold recharge of a geothermal reservoir since calcite precipitates from a saturated fluids as the fluid temperature increases. However, calcite is not an uncommon accessory mineral in basaltic rocks, and its presence is not necessarily indicative of geothermal activity. Therefore, an analysis of the significance of calcite in samples of Lanipuna #1 will not be attempted at this time.

Thin sections of drill cuttings from Lanipuna #1 show that trace amounts of epidote are present throughout the entire drilled section. The crystals are generally so small that they are impossible to detect without a thin section. The plot of detected epidote refers to clusters of terminated crystals which form in rock voids. These clusters were detected fairly regularly below 7,000 feet in Lanipuna #1. The significance of their appearance below that depth is uncertain but it may be related to a change in metamorphic facies.

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APPENDIX A

Lithologic Log, Lanipuna #1/Sidetrack

LITHOLOGIC LOG

Lanipuna #1 ST

True Vertical Depth Interval, feet	
	Completion Date: May 20, 1983
3,620	100% BASALT, Type B. Description: Nonvesicular, basalt porphyry with abundant phenocrysts of colorless plagioclase and black to green pyroxene embedded in a matrix of intergrown feldspar and pyroxene and minor glass. Alteration: Groundmass feldspars are chalky white to clay.
3,630	100% BASALT, Type C. Description: Nonvesicular, basalt porphyry with few scattered phenocrysts of plagioclase and pyroxene embedded in a chalky, pale gray-green matrix. Alteration: Extensive groundmass alteration to clay and chlorite.
3,655	CLAY. Description: Blue-green to gray.
3,680	80%, Type B. Description: Nonvesicular, basalt porphyry with scattered to abundant phenocrysts of pyroxene and plagioclase embedded in a fine crystalline matrix of intergrown feldspar and pyroxenes with minor glass. Alteration: Pyrite disseminations, minor clay replaces groundmass feldspar. 20%, Type C. Description: Nonvesicular vitrophyre, no alteration.
3,690	90%, Type B. Description: Nonvesicular, basalt porphyry with scattered phenocrysts of pyroxene and plagioclase in a fine crystalline matrix. Alteration: Extensive groundmass alteration to clay and chlorite evidenced by (1) rounded clasts and (2) blue-green color. 10%, Type C. Description: Nonvesicular vitrophyre with no alteration.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

3,720 95%, Type B.
Description: Nonvesicular basalt porphyry as above.
Alteration: Extensive groundmass alteration of feldspar to white, chalky material. Traces of milky chalcedony veins. Minor pyrite disseminations.
5%, Type C.
Description: Vitrophyre. No alterations.

3,740 100%, Type B.
Description: Nonvesicular basalt porphyry as above.
Alteration: Extensive groundmass alteration of feldspars to chalky white material. Incipient alteration of plagioclase phenocrysts with white patches.

3,740-3,820 No sample.

3,840 90%, Type B.
Description: Nonvesicular basalt with rare phenocrysts of plagioclase and clinopyroxene in a fine crystalline matrix of feldspar and clinopyroxene.
Alteration: Minor alteration of groundmass feldspars to a white, chalky material. Minor amounts of vein quartz. Minor pyrite coating fracture surfaces.
10%, Type C.
Description: Nonvesicular vitrophyre (probably devitrified as indicated by its dull luster).

3,855 100%, Type B.
Description: Nonvesicular basalt as above.
Alteration: Minor alteration of groundmass feldspars to white color. Minor amounts of free quartz. Some pyrite coating fracture surface.

3,875 100%, Type B.
Description: Nonvesicular basalt as above.
Alteration: Groundmass alteration is variable, nil to moderate with patches of altered white feldspar and a few green patches indicating alteration of mafics to chlorite. Vein fillings of quartz, pyrite and chalky white to gray-green material are abundant, approximately 10% of the sample.

3,891 100%, Type B.
Description: Nonvesicular basalt as above.
Alteration: Restricted to abundant vein material (10% volume) of quartz, pyrite and chalky material with some chlorite alteration at vein boundaries.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

3,911 Type B.
Description: Nonvesicular basalt with rare phenocrysts of clinopyroxene and plagioclase. Groundmass crystals are very fine and may be devitrified glass.
Alteration: Negligible except for vein material (5%) as described above.

3,936 50%, Type D.
Description: Nonvesicular basalt with scattered phenocrysts of clinopyroxene and plagioclase in a fine crystalline matrix.
Alteration: Restricted to groundmass feldspars and some veins of quartz and pyrite.

50%, Type B.
Description: Nonvesicular basalt as above.
Alteration: Restricted to veins (5%) of quartz and pyrite. Some chloritization near veins.

3,950 20%, Type C.
Description: Vitrophyre with scattered phenocrysts of clinopyroxene and plagioclase.
Alteration: Restricted to vein material of quartz, pyrite and chlorite.
80%, Type B.
Description: Basalt as above.
Alteration: Intense alteration of the rock to a gray-green color with numerous nodules of dark green chlorite and abundant free quartz and pyrite.

3,970 100%, Type B.
Description: Aphanitic basalt with scattered phenocrysts of plagioclase and clinopyroxene.
Alteration: minor, incipient alteration of groundmass feldspars with 3% vein material of quartz and pyrite.

3,995 90%, Type D.
Description: Fine crystalline basalt of interlocking plagioclase and clinopyroxene in a cumulate texture.
Alteration: Plagioclase is pervasively altered white. Overall color of clasts is gray-green (chlorite).
10%, Type C. As above.

4,009 70%, Type D.
Description: Fine crystalline basalt, as above.
Alteration: Pervasive feldspar alteration to a white color. Minor pyrite.

30%, Type B.
Description: Aphanitic basalt with scattered phenocrysts.
Alteration: Phenocrysts are very fresh. Groundmass is probably devitrified glass. Alteration is negligible.

4,043 50%, Type D. As above.
50%, Type B.
Description: Aphantic basalt, as above.

4,068 100%, Type D.
Description: Fine crystalline basalt as described above.
Alteration: Slight. Alteration of groundmass feldspars is pervasive. Minor waxy chlorite occurs, coating fracture surfaces. Trace amounts of pyrite and quartz in vugs.

4,087 100%, Type D.
Description: Fine to very fine crystalline basalt with scattered phenocrysts of clinopyroxene and plagioclase.
Alteration: Alteration of clasts is moderate to intense and 50% of all clasts are thoroughly altered to soft, friable material. Pyrite and quartz occur in trace amounts as disseminations. Rock color is dull gray.

4,107 85%, Type D.
Description: Fine crystalline basalt as described above.
Alteration: For groundmass, alteration of minerals is pervasive, ranging from slight to moderate with very few friable clasts.
15%, Type C.
Description: Vitrophyre, aphyric.
Alteration: Restricted to devitrification.

4,127 75%, Type D.
Description: Fine crystalline basalt as above.
Alteration: Groundmass alteration is patchy with some intersertial chlorite and feldspar alteration. Pyrite occurs in trace amounts.
25%, Type B.
Description: Aphanitic basalt with no apparent alteration.

4,151 80%, Type D.
Description: Fine crystalline basalt as above.
Alteration: Restricted to small patches of white groundmass feldspar and rare occurrences of intersertial chlorite.
20%, Type B.
Description: Aphanitic basalt as above.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

4,170 50%, Type D. as above.
50%, Type B.
Description: As above.
Alteration: Negligible except for minor occurrences of free gypsum, quartz and pyrite open space fillings.

4,190 50%, Type D.
Description: As above.
Alteration: Patchy. Some clasts are divided into unaltered zones and moderately altered friable zones.
50%, Type B.
Description: As above.
Alteration: Slight and generally restricted to feldspars.

4,209 60%, Type D.
Description: As above.
Alteration: For groundmass feldspars and intersertial materials, alteration is pervasive, moderate to intense. Most altered clasts are gray and white friable material.
40%, Type B.
Description: As above.
Alteration: Variable, nil to slight. Most altered clasts exhibit alteration of groundmass feldspars.

4,223 60%, Type D. As above.
40%, Type B. As above.

4,235 100%, Type D.
Description: As above.
Alteration: Variable. 80% of all clasts are moderately altered with white feldspars and intersertial chlorite. 20% of all clasts show very little alteration. Free pyrite, quartz and gypsum are present in minor amounts.

4,254 Type B.
Description: As above.
Alteration: Variable, with slight to moderate alteration of groundmass feldspars. Quartz and pyrite are present in trace amounts.

4,278 Type B.
Description: As above.
Alteration: Variable, with slight to moderate alteration of groundmass feldspars. Veins of quartz, pyrite and chlorite are minor but conspicuous.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

4,298 Type B.
Description: As above.
Alteration: Variable, slight to intense. Most altered clasts are reduced to either a white chalky, friable material or to chlorite. Veins of pyrite, quartz and chlorite are conspicuous in minor quantities.

4,317 50%, Type B.
Description: As above.
Alteration: Minor and restricted to chloritization near veins of quartz, pyrite and chlorite. Veins occur in trace amounts.
50%, Type C.
Description: Vitrophyre.
Alteration: Devitrification and trace amounts of veins containing pyrite, quartz, gypsum and chlorite.

4,335 Type D.
Description: Fine crystalline basalt composed of interlocking crystals of feldspar and pyroxene.
Alteration: Pervasive, but minor with some whitening of feldspars. Some slickensides observed.

4,354 80%, Type D. As above.
20%, Type C.
Description: Aphyric vitrophyre.
Alteration: Consists of devitrification and minor occurrences of pyrite.

4,373 80%, Type B.
Description: Porphyritic basalt with scattered phenocrysts of pyroxene and plagioclase in an aphanitic matrix.
Alteration: Variable, slight to moderate. Most altered clasts contain altered feldspar and chloritized pyroxenes.
20%, Type C.
Description: Vitrophyre, as above.

4,386 85%, Type B.
Description: As described above.
Alteration: Slight, with minor occurrences of chlorite or altered feldspars.
15%, Type C.
Description: Unaltered vitrophyre.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

4,409 10%, Type B. As above.
90%, Type D.
Description: Fine to very fine crystalline basalt.
Alteration: Pervasive and moderate with white feldspar crystals and chlorite replacing pyroxened intersertial glass. Quartz and pyrite occur in trace amounts.

4,428 10%, Type B. As above.
90%, Type D. As above.

4,446 20%, Type B. As above.
80%, Type D.
Description: As above.
Alteration: Variable, slight to moderate. Most altered clasts contain abundant chlorite in the groundmass.

4,465 50%, Type B.
Description: As above.
Alteration: Variable, slight to moderate. Most altered samples contain abundant groundmass chlorite and trace amounts of pyrite and quartz.
50%, Type D.
Description: As above, with same slickensides observed on extremely altered, friable clasts.

4,485 50%, Type B. As above.
50%, Type D.
Description: As above, with an abundance of extremely altered chalky friable clasts which appear to be slickensides.

4,504 100%, Type B.
Description: Scattered phenocrysts of clinopyroxene and plagioclase in an aphanitic or very fine crystalline groundmass with feldspar laths and intersertial glass, mafics and iron ore.
Alteration: Slight except for rare clasts of white friable material.

4,522 40%, Type B.
Description: As above.
Alteration: Variable, slight to moderate. Chlorite is the dominant alteration product replacing groundmass mafics and glass.
40%, Type D.
Description: Fine crystalline basalt with phenocrysts of olivine, pyroxene and plagioclase.
Alteration: Alteration of groundmass mafics to chlorite, and feldspars to chalky material, is pervasive.

20%, Type C.
Description: Vitrophyre with scattered phenocysts of olivine, pyroxene and plagioclase.
Alteration: Restricted to devitrification and some chloritization in brecciated clasts.

4,536 80%, Type B.
Description: As above.
Alteration: Pervasive and intense. Clasts are all pale green and friable. Pyrite is conspicuous.
20%, Type C. As above.

4,560 80%, Type B.
Description: As above.
Alteration: Slight, except for a few friable clasts of chalky, striated material.
20%, Type C. As above.

4,579 80%, Type B.
Description: Rare phenocrysts of olivine, pyroxene and plagioclase are embedded in a groundmass of feldspar laths and intersertial glass, mafics and opaques.
Alteration: Moderate alteration of intersertial groundmass constituents to chlorite and feldspar laths to chalky material is pervasive. Some slickensides are noted. Quartz and pyrite occur in trace amounts.
20%, Type C.
Description: Vitrophyre
Alteration: Restricted to devitrification.

4,598 20%, Type C.
Description: Vitrophyre.
Alteration: Variable with some fresh clasts and some devitrified clasts.
60%, Type B.
Description: Scattered phenocrysts are embedded in an aphanitic matrix.
Alteration: Alteration of groundmass constituents is moderate.
20%, Type D.
Description: Fine crystalline rock composed of plagioclase and pyroxene.
Alteration: Alteration of feldspars to a white substance and pyroxenes to chlorite is pervasive.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

4,616 Type B.
Description: As above.
Alteration: Variable, slight to intense, but most clasts appear fresh except for altered feldspars.

4,634 80%, Type B.
Description: As above.
Alteration: Variable, slight to moderate. Most altered clasts contain white feldspars and intersertial chlorite. Minor pyrite and traces of quartz.
20%, Type C.
Description: Vitrophyre.
Alteration: Slight to nil.

4,653 90%, Type B.
Description: As above.
Alteration: Moderate. Most clasts contain altered white feldspars and chloritized intersertial material.
10%, Type C. As above.

4,671 70%, Type B.
Description: As above, with trace amounts of quartz and pyrite in veins.
30%, Type C.
Description: Vitrophyre.
Alteration: Restricted to variable devitrification and trace occurrences of pyrite.

4,685 75%, Type B. As above.
25%, Type C. As above.

4,708 50%, Type B. As above.
50%, Type C. As above.

4,725 Type D.
Description: Fine crystalline rock with rare phenocrysts of olivine, pyroxene and plagioclasts.
Alteration: Moderate and pervasive with chalky feldspars and chlorite pseudomorphs after pyroxene.

4,745 20%, Type D. As above.
80%, Type B.
Description: Scattered phenocrysts in an aphanitic groundmass.
Alteration: Variable, but slight, with rare quartz and pyrite.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

4,764 Type B. As above.

4,783 Type B.
Description: As above.
Alteration: Variable, slight to moderate. Least altered clasts appear fresh except for devitrification of groundmass glass. Most altered clasts are pale green and have chalky altered feldspars.

4,800 50%, Type B. As above.
50%, Type D.
Description: Fine crystalline basalt.
Alteration: Alteration of feldspars is pervasive. Intersertal material is gray-green indicating chlorite.

4,826 50%, Type B. As above.
50%, Type D. As above.

4,845 Type B-D.
Description: Aphanitic to fine crystalline rock.
Alteration: Variable. Very light to moderate. Most clasts display little or no alteration. About 5-10% of all clasts contain chalky white feldspars and patches of groundmass chlorite, traces of quartz and pyrite.

4,858 100%, Type B-D. As above.

4,877 Type B. As above.

4,885 85%, Type B. As above.
15%, Type D.
Description: Fine crystalline basalt.
Alteration: Alteration for feldspars to chalky material and pyroxene to chlorite is pervasive.

4,913 60%, Type D. As above.
40%, Type B.
Description: As above.
Alteration: Alteration of groundmass feldspars to chalky substance is pervasive. Intersertal material is colored pale green by chlorite.

4,930 75%, Type D.
Description: As above, with some slickensides and trace amounts of quartz and pyrite.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

25%, Type C,
Description: Vitrophyre.
Alteration: Restricted to devitrification.

4,948 80%, Type D.
Description: Fine crystalline basalt.
Alteration: Alteration of feldspars to chalky material is pervasive. Alteration of groundmass mafics to chlorite is pervasive. Minor amounts of pyrite. Traces of quartz.
10%, Type C.
Description: Vitrophyre.
Alteration: Restricted to devitrification.
10%, Type B.
Description: Aphanitic basalt porphyry with scattered phenocrysts of plagioclase and pyroxene.
Alteration: Alteration of feldspars is pervasive. A green tint to the groundmass indicates the presence of chlorite.

4,962 50%, Type D. As above.
25%, Type B. As above.
25%, Type C. As above.

4,990 50%, Type B.
Description: As above.
Alteration: Alteration of feldspars and groundmass mafics is pervasive. Groundmass glass is dull black. Trace amounts of pyrite and quartz in fractures.
50%, Type C.
Description: Vitrophyre.
Alteration: Many rounded clasts are coated with chlorite. Fractures are probably related to eruption of the lava. Glass is dull black. Trace amounts of quartz and pyrite occur as veins.

5,002 Type C.
Description: Vitrophyre.
Alteration: Variable. 50% of all clasts are slightly altered with devitrification, some chalky feldspars and minor chlorite coating fractures. 50% are moderately altered with chalky feldspars, chloritized mafics and a gray-green groundmass.

5,020 50%, Type C.
Description: Vitrophyre.
Alteration: Variable, but slight.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

50%, Type B.
Description: Aphanitic basalt porphyry.
Alteration: Alteration of groundmass contituents to chlorite is pervasive. Groundmass color is gray-green. Quartz and pyrite occur in trace amounts.

5,038 Type B.
Description: As above.
Alteration: Variable. 75% of all clasts appear fresh, almost glassy. 25% are pale green, friable material.

5,056 Type B. As above.

5,075 Type B.
Description: As above.
Alteration: Variable. 75% of all clasts appear fresh with trace amounts of quartz and pyrite. 25% of all clasts are composed of pale green waxy chlorite with minor amounts of pyrite.

5,093 Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Alteration of groundmass constituents is variable, light to intense. Quartz is conspicuously abundant.

5,111 Type B.
Description: Aphanitic basalt.
Alteration: Very slight, with trace amounts of quartz.

5,130 Type B.
Description: Aphanitic basalt.
Alteration: Variable, none to moderate. Most clasts appear black, glassy and unaltered. About 10% are gray-green, and composed mostly of chlorite. A few slickensides are present. Pyrite occurs in trace amounts.

5,143 Type D.
Description: Very fine crystalline basalt.
Alteration: Variable, but pervasive slight to moderate. Least altered samples have chalky feldspars and black, glassy intersertial material. Most altered, have chalky feldspar and intersertal chlorite.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

5,161 50%, Type D. As above.
20%, Type C.
Description: Vitrophyre, devitrified but otherwise unaltered.
30%, Type B.
Description: Aphanitic basalt.
Alteration: Slight. Trace amounts of massive quartz.

5,179 50%, Type D. As above.
50%, Type C.
Description: Vitrophyre, devitrified to a dull black.

5,202 80%, Type B.
Description: Very fine crystalline to aphanitic basalt.
Alteration: Pervasive with chalky feldspars and gray-green intersertial chlorite. Traces of quartz.
20%, Type C. As above.

5,225 100%, Type B.
Description: As above.
Alteration: Variable, slight to moderate. Least altered clasts are glassy and black with frosty feldspars. Moderately altered clasts contain gray-green chlorite and white, chalky feldspars. 5% of all clasts are white, striated and friable.

5,239 Type B.
Description: As above.
Alteration: Pervasive but slight, with frosted feldspars and chlorite coating fracture surfaces. Less than 5% of the clasts are friable.

5,254 Type B.
Description: As above.
Alteration: Variable. 90% of all clasts contain white feldspars and gray-green intersertal chlorite. 10% of all clasts are only slightly altered wiht no evidence of chlorite.

5,272 Type B.
Description: As above.
Alteration: Variable. 70% of all clasts display altered feldspars and gray-green intersertal chlorite. 30% display lesser degrees of alteration with minor amounts of pyrite.

5,290 90%, Type B.
Description: Aphanitic basalt.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

Alteration: Variable, slight to moderate. Slightly altered clasts are dull black, contain altered feldspars and traces of pyrite. Moderately altered clasts are gray-green with altered feldspars and intersertal chlorite.
10%, Type C. As Above.

5,308 90%, Type B.
Description: Aphanitic basalt.
Alteration: Variable, but most clasts display little with frosted feldspars in a dull grey or black groundmass.
10%, Type C. As above.

5,329 Type B.
Description: Very fine crystalline basalt.
Alteration: Variable. 75% of all clsts appear fresh or only lightly altered. 25% of all clasts are composed of white and black friable material.

5,347 85%, Type B.
Description: Very fine crystalline basalt.
Alteration: Slight to moderate. Most altered clasts contain white feldspars in a gray-green chlorite-rich matrix. About 5% of all clasts are composed of friable materials.
15%, Type C.
Description: Vitrophyre.
Alteration: Slight.

5,365 80%, Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Alteration of feldspars to chalky material is pervasive. Intersertal material is black, showing little alteration. Trace amounts of chlorite coat fracture surfaces.
20%, Type C.
Description: Vitrophyre.
Alteration: Restricted to incipient devitrification and traces of quartz and pyrite veins.

5,384 100%, Type B.
Description: As above.
Alteration: Variable. 45% of all clasts are glassy and show little alteration except for frosted feldspars. 45% are moderately altered with white feldspars and gray intersertal material, 10% are intensely altered to friable material. Quartz and pyrite occur in trace amounts.

5,402 90%, Type B.
Description: Very fine crystalline basalt with rare phenocrysts.
Alteration: Pervasive, with white feldspars and dark green intersertal chlorite. Pyrite and massive quartz occur in traces.
10%, Type C.
Description: Vitrophyre.
Alteration: Restricted to incipient devitrifications.

5,415 80%, Type B. As above.
20%, Type C. As above.

5,433 100%, Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Variable. Aphanitic clasts are dark gray to black with altered groundmass feldspars. Coarser crystalline clasts are green with abundant intersertal chlorite. Pyrite and quartz are rare.

5,452 100%, Type B.
Description: Aphanitic basalt with scattered mafic phenocrysts.
Alteration: Patchy, ranging from low to moderate. Least altered clasts are dark brown or black and show little alteration except for white feldspars. Most altered clasts are gray with chlorite coatings on fracture surfaces. Quartz occurs in trace amounts.

5,470 80%, Type D.
Description: Fine crystalline basalt.
Alteration: Pervasive and moderate, with chalky feldspars within a green chlorite-rich matrix. About 5% of the clasts of intensely altered to friable material. Traces of quartz.
20%, Type B. As above.

5,488 90%, Type D. As above.
10%, Type B. As above.

5,507 100%, Type B.
Description: Very fine crystalline to aphanitic basalt.
Alteration: Alteration of groundmass feldspars is pervasive. Intersertal material is dark gray with only occassional patches of green chlorite-rich material. Pyrite and quartz are rare.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

5,525 100%, Type B.
Description: Very fine crystalline basalt.
Alteration: Alteration of the groundmass is pervasive with altered feldspar within an olive green chlorite-rich matrix. Pyrite is present in minor amounts and quartz in traces.

5,543 100%, Type B.
Description: As above.
Alteration: Variable. Most clasts are as above, with altered feldspars within an olive green matrix. About 30% appear fresher with a dark brown or black matrix.

5,557 40%, Type B. As above.
60%, Type C.
Description: Vitrophyre.
Alteration: Intense. Clasts are composed of very soft waxy off-white material with dark green crystals and nodules of chlorite and abundant [illegible]ite. Quartz occurs in trace amounts.

5,580 65%, Type B. As above.
35%, Type C. As above.

5,591 100%, Type B.
Description: Very fine to aphanitic basalt.
Alteration: Variable, according to crystalline size. Aphanitic rocks are least altered but contain altered feldspars and veins of chlorite. More crystalline clasts are pervasively altered to chlorite.

5,613 80%, Type B.
Description: Aphanitic basalt.
Alteration: Slight to moderate.
20%, Type C.
Description: Vitrophyre, devitrified.

5,631 90%, Type B.
Description: Very fine crystalline basalt.
Alteration: Pervasive with white feldspars and intersertal chlorite. Massive quartz and pyrite occur in trace amounts.
10%, Type C. As Above.

5,650 90%, Type B. As above.
10%, Type C. As above.

5,672 90%, Type B. As above.
10%, Type C. As above.

5,691 65%, Type D.
Description: Fine-crystalline basalt.
Alteration: Pervasive, with white feldspar in an intersertal, chlorite-rich matrix. Quartz and pyrite are rare.
25%, Type B.
Description: Aphanitic basalt.
Alteration: Slight and restricted to devitrification and minor amounts of chlorite coating fracutres.
10%, Type C.
Description: Clay, gray-green.

5,709 65%, Type D. As above.
35%, Type B. As above.

5,731 65%, Type D. As above.
35%, Type B. As above.

5,746 45%, Type D.
Description: Fine crystalline basalt.
Alteration: Pervasive, slight to moderate, consisting of white feldspar and chlorite.
55%, Type B.
Description: Aphanitic basalt.
Alteration: Slight to none. Most altered clasts contain white chalky feldspars. Least altered exhibit glassy matrices.

5,764 100%, Type B.
Description: Aphantic basalt.
Alteration: Variable, slight to moderate. About 50% of all clasts contain white, chalky feldspars and gray intersertal material, and 50% of all clasts are glassy, exhibiting very little alteration.

5,787 100%, Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Ranges from slight to intense. About 20% all clasts are glassy and only slightly altered. 60% of all clasts exhibit moderate alteration of feldspar and intersertal glass to chlorite. 20% of all clasts are intensely altered to friable material.

5,805 100%, Type B.
Description: As above, with trace amounts of terminated quartz.

5,828 100%, Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Ranges from slight to moderate. 30% of all clasts exhibit slight alteration with incipient groundmass alteratis and a few fractures coated with chlorite. 65% clasts are moderately altered with chalky feldspars and abundant intersertal and nodular chlorite. Pyrite and terminated quartz occur in trace amounts. 5% of all clasts are friable.

5,846 100%, Type B.
Description: As above but terminated quartz and pyrite occur in minor amounts.

5,864 100%, Type B.
Description: Aphanitic basalt.
Alteration: Variable, slight to moderate. Most clasts are only slightly altered with chalky feldspar and gray intersertal material. About 20% of all clasts are moderately altered with abundant chlorite. Quartz and pyrite occur in trace amounts.

5,878 100%, Type B.
Description: Aphanitic basalt.
Alteration: As above with 50% all clasts showing slight alteration, 40%, moderate alteration and 10% of all clasts are friable. Quartz and pyrite occur in trace amounts.

5,895 100%, Type B.
Description: Very fine crystalline to aphanitic basalt.
Alteration: Variable, ranging from slight to moderate. 25% of all clasts are black, dense rock, exhibiting incipient groundmass devitrification and sporadic occurrences of chlorite in fractures. 60% of all clasts are more crystalline. These contain chalky feldspars in gray to gray-green chlorite-rich matrices. Massive vein quartz and pyrite is a minor occurrence in these clasts. 15% of all clasts are intensely altered to friable material.

5,915 100%, Type D.
Description: Fine crystalline basalt.
Alteration: Variable. 80% of all clasts are slightly to moderately altered with chalky or frosted feldspars and minor intersertal chlorite. 20% of all clasts are altered to friable material. Pyrite occurs in traces but quartz is absent.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

5,938 50%, Type B.
Description: Aphanitic to very fine crystalline, basalt.
Alteration: Variable, slight to moderate.
50%, Type D. As above.

5,951 85%, Type B. As above.
15%, Type C(?).
Description: Vitrophyre(?), pale green.
Alteration: Highly altered vitrophyre(?). Alteration: of the matrix to a chlorite-rich assemblage is pervasive. Pyrite occurs in minor amounts.

5,967 70% Type B.
Description: Aphanitic basalt.
Alteration: Very slight with sporadic occurrences of chlorite.
20%, Type D.
Description: Fine crystalline basalt.
Alteration: To chlorite is pervasive.
10%, Type C.
Description: Brecciated vitrophyre.
Alteration: As above.

5,985 100%, Type B.
Description: Aphanitic basalt porphyry with abundant brown mafic phenocrysts.
Alteration: Chlorite is pervasive and conspicuous with patches of large pale-green chlorite crystals in the groundmass. Pyrite occurs in minor quantities and vein quartz occurs in trace amounts.

6,006 100%, Type B.
Description: As above.
Alteration: Variable. 75% of all clasts are pervasively altered to chlorite as described above. 25% of all clasts show very little alteration.

6,025 80%, Type B.
Description: Aphanitic basalt.
Alteration: Slight with rare patches of groundmass chlorite in an otherwise fresh-appearing rock.
20%, Type C.
Description: Pale-green vitrophyre(?).
Alteration: Chlorite is pervasive.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

6,039 90%, Type B.
Description: Aphanitic basalt.
Alteration: Variable, slight to moderate. Most altered clasts contain patches of groundmass chloride, forming crystal splays. Terminated quartz occurs in trace amounts.
10%, Type C. As above.

6,057 50%, Type B. As above.
50%, Type C. As above.

6,076 100%, Type B.
Description: Aphanitic basalt
Alteration: Variable, slight to moderate. Most altered clasts contain abundant groundmass chlorite and fracture surfaces coated in chlorite and pyrite.

6,100 100%, Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Variable, slight to moderate. About 50% of all clasts are slightly altered with chlorite in fractures. The other half contain groundmass chlorite, chalky feldspars and minor pyrite. Quartz is present in trace amounts.

6,117 100%, Type B.
Description: Aphanitic basalt.
Alteration: Very slight.

6,135 100%, Type B. As above.

6,149 100%, Type B.
Description: Aphanitic basalt.
Alteration: Variable, slight to intense. 40% of all clasts are black and dense with little signs of alteration. 50% are green and chalky with all original textures erased. 10% are midway between the two extremes with patches of elongate chlorite and patches of relatively unaltered material. Pyrite occurs in minor amounts. Quartz is absent.

6,167 100%, Type B.
Description: Aphanitic basalt.
Alteration: Variable, moderate to intense. 10% of all clasts show little or no alteration. The other 90% display a wide range of alteration to chlorite and pyrites. Most altered clasts are green and chalky (clay?) with nodules of dark green chlorite and pyrite.

LITHOLOGIC LOG

Lanipuna #1 ST (continued)

6,185 100%, Type B.
Description: Aphanitic to very fine crystalline basalt.
Alteration: Moderate and pervasive with abundant groundmass chlorite and minor pyrite.

6,210 100%, Type B.
Description: Aphanitic basalt.
Alteration: 90% of all clasts is pervasive and intense to chalky green material containing nodules of dark green chlorite and pyrite. 10% of all clasts are slightly to moderately altered with groundmass chlorite.

6,227 100%, Type B.
Description: Aphanitic basalt.
Alteration: To groundmass chlorite is slight to moderate.

6,250 100%, Type B.
Description: Aphanitic basalt.
Alteration: Extremely variable, ranging from nil to intense. Most altered clasts are composed of white and black or white and green friable material. Least altered clasts are black and dense.

6,269 100%m Type B.
Description: As above.
Alteration: Most clasts are only slightly altered.

6,271 100%m Type B.
Description: Aphanitic basalt.
Alteration: Chlorite is variable, slight to moderate. Quartz and pyrite occur in trace amounts.

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APPENDIX B

Temperature Surveys, Lanipuna #1/Sidetrack

TEMPERATURE SURVEYS

Lanipuna #1/Sidetrack

1.	June 4	Saturday, 10:00 a.m., bottomhole temperature at 4,998 feet TVD at 7 hours after drilling.
2.	June 5	Sunday, 9:30 a.m.-12:00 p.m., about 30 hours after circulating (temperature and pressure)
3.	June 6	Monday, 8:30-9:30 a.m., about 54 hours after circulating.
4.	June 8	Wednesday, 8:00-9:30 a.m., bottomhole temperature at 5,289 feet TVD (5,391 feet measured depth), about 6-1/2 hours after circulating.
5.	June 11	Saturday, 8:00-10:00 a.m., bottomhole temperature at 5,816 feet TVD, about 7-1/2 hours after circulating.
6.	June 12	Sunday, 9:00 a.m.-12:00 p.m., about 31 hours after circulating.
7.	June 13	Monday, 3:20-5:00 a.m., 46 hours after circulating. Ten minute stations were too short.
8.	June 13	Monday, 12:00-3:00 p.m., 53 hours after circulating. Gearhart-Owens.
9.	June 13	Monday, 6:00-8:00 p.m., 56 hours after circulating. Kuster clock stopped at 5,400 feet TVD.
10.	June 14	Tuesday, 8:00-10:00 a.m., 70 hours after circulating. Gearhart-Owens. Hole bridged around 5,600 feet TVD.
11.	June 16	Thursday, 2:00-4:00 p.m., 6 hours after circulating at 6,097 feet TVD (6,272 feet measured depth). Gearhart-Owens.
12.	June 16	Thursday, 5:00-6:30 p.m., 8 hours after circulating at 6,097 feet TVD. Kuster.
13.	June 18	Saturday, 10:00 a.m.-2:00 p.m., 6 hours after circulating at 6,271 feet TVD. Gearhart-Owens.
14.	June 19	Sunday, (run by Murray C. Gardner), 10:00 a.m., 31 hours after circulating at 6,271 feet TVD. Gearhart-Owens.
15.	June 20	Monday, 3:00 p.m., 60 hours after circulating.

Temperature Surveys, Lanipuna #1/Sidetrack (continued)

16.	June 21	Tuesday, 1:00-5:00 p.m., about 8-1/2 hours after circulating (stopped circulating at 3:30 a.m.). Survey conducted with 3 runs: 1 Gearhart-Owens and 2 Kusters. Fluid level = 492 RKB.
17.	June 22	Wednesday, 10:00 a.m.-12:00 p.m., 27-1.2 hours after circulating. Fluid level = 575 RKB
18.	June 23	Thursday, 10:00 a.m.-12:00 p.m., 51-1/2 hours after circulating. Fluid level = 634 RKB. (Also ran pressure bomb to 4,000 feet TVD).
19.	June 24	Friday, 10:00 a.m.-12:00 p.m., 75-1/2 hours after circulating. Fluid level = 648 RKB.
20.	June 27	Monday, 10:00 a.m.-12:00 p.m., 147-1/2 hours after circulating. Fluid level = 647 RKB.
21.	July 14	Thursday, 10:00 a.m.-12:00 p.m.
22.	July 18	Monday, 11:54 a.m.-12:24 p.m.
23.	July 18	Monday, 3:05 p.m.-3:35 p.m.
24.	July 19	Tuesday, 9:30 a.m.- 12:00 p.m.
25.	July 20	Wednesday, 10:45 a.m.-12:35 p.m.
26.	July 22	Friday
27.	July 30	Saturday, 8:45 a.m.

Lanipuna #1/Sidetrack - Survey #1

June 4, 1983, Saturday, 10:00 a.m.

7 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F
5,070	4,998	346

Lanipuna #1/Sidetrack - Survey #2

June 5, 1983, Sunday, 9:30 a.m.-12:00 p.m.

30 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,400	4,376	269
4,600	4,565	284
4,800	4,752	311
5,069	5,000	388

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F	Gradient/ 1,000 feet
2,000	2,000	923	461
3,000	3,000	1,396	465
4,000	4,000	1,854	464

*Corrected for calibration at 212°F.

Lanipuna #1/Sidetrack - Survey #3

June 6, 1983, Monday, 8:30-9:30 a.m.

54 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,400	4,376	284
4,600	4,565	306
4,800	4,752	336
5,070	5,000	391

*Corrected from calibration in boiling water.

Lanipuna #1/Sidetrack - Survey #4

June 8, 1983, Wednesday, 8:00-9:30 a.m.

6-1/2 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
5,391	5,289	334

*Corrected from calibration in boiling water.

Lanipuna #1/Sidetrack - Survey #5

June 11, 1983, Saturday, 8:00-10:00 a.m.

7-1/2 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
5,070	4,998	234
5,391	5,289	248
5,967	5,816	282

*Corrected values.

Lanipuna #1/Sidetrack - Survey #6

June 12, 1983, Sunday, 9:00 a.m.-12:00 p.m.

31 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
5,070	5,000	305
5,181	5,100	319
5,293	5,200	324
5,402	5,300	328
5,512	5,400	329
5,621	5,500	331
5,731	5,600	327
5,839	5,700	327
5,960	5,816	332

*Corrected values.

Lanipuna #1/Sidetrack - Survey #7

June 13, 1983, Monday, 3:20-5:00 a.m.

Kuster

Stations were 10 minutes each in thick mud, and recorded temperatures did not have time to equilibrate with formation temperatures.

Lanipuna #1/Sidetrack - Survey #8

June 13, 1983, Monday, 12:00-4:00 p.m.

53 hours after circulation

Gearhart-Owens

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
40		79.6
50		80.8
60		81.0
80		82.5
90		91.3
100		93.5
150		92.6
200		90.7
250		91.6
300		94.1
350		96.6
400		99.6
450		100.4
500		100.3
550		103.5
600		107.8
650		111.3
700		116.5
750		116.8
800		199.5
850		121.1
900		121.0
950		119.7
1,000		118.1
1,050		116.1
1,100		114.6
1,150		113.4
1,200		112.8
1,250		112.7
1,300		112.8
1,350		113.4
1,400		113.8
1,450		114.6
1,500		115.4

Lanipuna #1/Sidetrack - Survey #8

(continued)

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
1,550		116.5
1,600		117.7
1,650		119.1
1,700		120.8
1,750		124.0
1,800		126.6
1,850		129.0
1,900		132.1
1,950		134.5
2,000		136.9
2,050		139.2
2,100		142.5
2,150		144.6
2,200		147.3
2,250		150.1
2,300		152.2
2,350		154.5
2,400		157.3
2,450		161.2
2,500		165.1
2,550		170.3
2,600		172.0
2,650		177.5
2,700		184.7
2,750		190.9
2,800		196.3
2,850		200.0
2,900		202.8
2,950		205.3
3,000		208.8
3,050		211.5
3,100		216.2
3,150		217.7
3,200		218.9
3,250		221.2
3,300		231.5**
3,350		235.6**
3,400		238.5**
3,450		240.5**
3,500		241.1**

Lanipuna #1/Sidetrack - Survey #8

(continued)

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F**
3,550		240.4
3,600		240.1
3,650		240.2
3,700		242.2
3,750		243.6
3,800		244.3
3,850		244.7
3,900		247.1
3,950		248.8
4,000		252.2
4,050		257.9
4,100		260.9
4,150		262.7
4,200	4,190	266.0
4,250		267.6
4,300		268.5
4,350		269.6
4,400	4,378	271.0
4,450		274.0
4,500		278.3
4,550		283.7
4,600	4,565	289.2
4,650		294.3
4,700		297.1
4,750		298.4
4,800	4,750	304.0
4,850		308.1
4,900		308.6
4,950		308.9
5,000	4,935	310.4
5,070	5,000	334.0
5,294	5,200	348.5
5,512	5,400	350.8
5,621	5,500	348.1
5,731	5,600	344.9
5,839	5,700	340.7
5,970	5,816	337.6

*Uncorrected.
**Corrected plus 8°F.

Lanipuna #1/Sidetrack - Survey #9

June 13, 1983, Monday, 6:00-8:00 p.m.

56 hours after circulation

Kuster

True Vertical Depth, feet	Temperature, °F*
4,600	298
5,000	341
5,400	354
5,816	Clock stopped

*Temperatures corrected, plus 10°F.

True Vertical Depth, feet	Pressure, psi	Gradient/ 1,000 feet
1,000	454	---
1,500	690	472
2,000	926	472
2,500	1,161	470
3,000	1,394	466
3,500	1,625	462
4,000	1,854	458

Lanipuna #1/Sidetrack - Survey #10

June 14, 1983, Tuesday, 8:00 a.m. (MCG)

70 hours after circulation

Gearhart-Owens

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
1,000	1,000	117.0
1,100	1,100	115.0
1,400	1,400	111.6
1,500	1,500	112.5
1,700	1,700	116.7
1,800	1,800	120.0
1,900	1,900	124.0
2,000	2,000	134.2
2,500	2,500	163.9
3,000	3,000	208.7
3,500	3,500	237.9
3,550	3,550	237.7
3,600	3,600	237.8
3,650	3,650	238.2
4,000	3,995	252.4
4,200	4,190	260.6
4,400	4,378	271.4
4,600	4,565	289.1
4,800	4,750	306.4
5,000	4,935	322.6
5,200	5,116	340.0
5,400	5,295	347.6
5,500	5,389	349.4
5,600	5,480	349.7
5,700	5,700	347.5**
5,800	5,800	345.3**
5,900	5,900	344.5**

*Reading recorded on the move.
**Questionable data: do not use, bridge in hole.

Lanipuna #1/Sidetrack - Survey #11

June 16, 1983, Thursday, 2:00-4:00 p.m.

6 hours after circulation

Gearhart-Owens

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
5,070	5,000	239.8
5,512	5,400	246.4
5,731	5,600	243.3
5,839	5,700	240.0
5,950	5,800	236.7
6,060	5,900	235.1
6,167	6,000	237.4
6,273	6,097	246.4

*Corrected: plus 8°F.

Lanipuna #1/Sidetrack - Survey #12

June 16, 1983, Thursday, 5:00-6:30 p.m.

8 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
5,070	5,000	244.0
5,512	5,400	260.0
5,950	5,800	256.0
6,280	6,097	273.0

*Corrected: plus 10°F.

Lanipuna #1/Sidetrack - Survey #13

June 18, 1983, Saturday, 10:00 a.m.-2:00 p.m.

6 hours after circulation

Gearhart-Owens

Measured Depth, feet	Temperature, °F*
3,400	194.5
3,450	194.6
3,460	194.7
3,470	195.0
3,480	195.4
3,490	195.6
3,500	195.9
3,510	196.1
3,550	196.7
3,600	195.5
3,610	195.6
3,620	194.7
3,630	194.8
3,640	194.4
3,650	194.1
3,700	198.9
3,800	200.1
3,950	202.4
4,000	203.4
4,020	203.6
4,050	203.1
4,060	204.1
4,070	204.3
4,080	204.5
4,090	205.6
4,100	206.0
4,150	209.0
4,424	216.2
4,630	222.8
4,855	230.3
4,960	235.0
5,070	238.2
5,182	243.0
5,192	241.2
5,202	242.3
5,212	241.7
5,222	241.6
5,234	242.6
5,512	244.9
5,621	244.5
5,721	241.8
5,732	240.8
5,743	239.7
5,764	239.0
5,775	238.6
5,800	238.8
5,839	235.3
5,850	234.7
5,861	234.4
5,873	233.9
5,885	235.0
5,960	232.6
5,971	231.8
5,983	232.0
6,068	230.6
6,080	229.4
6,092	230.2
6,170	233.0
6,275	225.1
6,287	225.0
6,300	225.0
6,382	225.0
6,474	224.6

*Corrected: plus 8°F.

Lanipuna #1/Sidetrack - Survey #14

June 19, 1983, Sunday, (run by MCG)

31 hours after circulation

Gearhart-Owens

True Vertical Depth, feet	Temperature, °F*
3,400	228
3,500	230
3,600	226
3,700	228
3,800	231
3,950	234
4,000	235
4,100	237
4,400	256
4,600	274
4,800	285
4,900	288
5,000	295
5,100	305
5,400	309
5,500	306
5,600	288
5,650	294
5,800	286
5,900	281
6,070	264
6,200	265
6,271	267

*Corrected: plus 8°F.

Lanipuna #1/Sidetrack - Survey #15

June 20, 1983, Monday, 3:00 p.m.

60 hours after circulation

Kuster

True Vertical Depth, feet	Temperature, °F*
5,000	319
5,500	328
6,200	284
6,274	280

*Corrected temperatures.

Lanipuna #1/Sidetrack - Survey #16

June 21, 1983, Tuesday, 1:00-5:00 p.m.

8-1/2 hours after circulation

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
	3,000	213.0
	3,050	214.7
	3,100	216.6
	3,150	218.3
	3,200	219.7
	3,250	221.5
	3,300	224.0
	3,350	226.8
	3,400	228.8
4,422	4,400	264
4,530	4,500	269
4,632	4,600	279
4,745	4,700	285
4,854	4,800	293
4,960	4,900	300
5,070	5,000	307
5,182	5,100	312
5,293	5,200	316
5,406	5,300	318
5,512	5,400	318
5,622	5,500	310
5,730	5,600	314
5,840	5,700	297
5,950	5,800	300
6,005	5,850	296
6,059	5,900	294
6,115	5,950	290
6,167	6,000	285
6,221	6,050	281
6,275	6,100	279
6,331	6,150	278
6,386	6,200	278
6,465	6,271	285

*Temperatures corrected by calibration.
Fluid level = 492 feet (rotary table).

Lanipuna #1/Sidetrack - Survey #17

June 22, 1983, Wednesday, 10:00 a.m.-12:00 p.m.

27-1/2 hours after circulation

Kuster

Fluid level = 575 (RKB)

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,422	4,400	281
4,854	4,800	319
5,070	5,000	333
5,182	5,100	339
5,293	5,200	344
5,406	5,300	345
5,512	5,400	344
5,622	5,500	343
5,730	5,600	337
5,840	5,700	327
5,950	5,800	320
6,059	5,900	313
6,167	6,000	303
6,275	6,100	295
6,386	6,200	290
6,465	6,271	294

*Temperatures corrected by calibration.

Lanipuna #1/Sidetrack - Survey #18

June 23, 1983, Thursday, 10:00 a.m.-12:00 p.m.

51-1/2 hours after circulation

Kuster

Fluid level = 634 (RKB)

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,422	4,400	292
4,854	4,800	334
5,070	5,000	348
5,182	5,100	354
5,293	5,200	359
5,406	5,300	360
5,512	5,400	359
5,622	5,500	356
5,730	5,600	346
5,840	5,700	339
5,950	5,800	331
6,059	5,900	322
6,167	6,000	311
6,275	6,100	304
6,386	6,200	298
6,465	6,271	301

*Temperatures corrected by calibration.

Lanipuna #1/Sidetrack - Survey #19

June 24, 1983, Friday, 10:00 a.m.-12:00 p.m.

75-1/2 hours after circulation

Kuster

Fluid level = 648 (RKB)

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,422	4,400	298
4,854	4,800	337
5,070	5,000	356
5,182	5,100	362
5,293	5,200	365
5,406	5,300	366
5,512	5,400	362
5,622	5,500	361
5,730	5,600	353
5,840	5,700	342
5,950	5,800	335
6,059	5,900	325
6,167	6,000	312
6,275	6,100	306
6,386	6,200	299
6,465	6,271	299

*Temperatures corrected by calibration.

Lanipuna #1/Sidetrack - Survey #20

June 27, 1983, Monday, 10:00 a.m.-12:00 p.m.

147-1/2 hours after circulation

Kuster

Fluid level = 647 (RKB)

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,422	4,400	313
4,854	4,800	349
5,070	5,000	367
5,182	5,100	375
5,293	5,200	378
5,406	5,300	378
5,512	5,400	376
5,622	5,500	370
5,730	5,600	360
5,840	5,700	351
5,950	5,800	341
6,059	5,900	333
6,167	6,000	319
6,275	6,100	310
6,386	6,200	304
6,465	6,271	303

*Temperatures corrected by calibration.

Lanipuna #1/Sidetrack - Survey #21

July 14, 1983, Thursday, 10:00 a.m.-12:00 p.m.

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,400		293
4,800		363
5,000		405
5,100		424
5,200		427
5,400		429
6,000		415
6,200		343
6,271		329

Lanipuna #1/Sidetrack - Survey #22

July 18, 1983, Monday, 11:54 a.m.-12:24 p.m.

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,400		360
5,200		428
5,400		429
6,200		342-344

Lanipuna #1/Sidetrack - Survey #23

July 18, 1983, Monday, 3:05 p.m.-3:35 p.m.

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
4,400		353
5,200		426
5,400		428
6,200		334

Lanipuna #1/Sidetrack - Survey #24

July 19, 1983, Tuesday, 9:30 a.m. - 12 noon

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
3,600		>332
4,000		347
4,200		354
4,400		359
4,600		364
4,800		367
5,200		360
5,400		357
5,700		328
6,000		314
6,200		306
6,271		306

Lanipuna #1/Sidetrack - Survey #25

July 20, 1983, Wednesday, 10:45 a.m.-12:35 p.m.

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
3,600		329
4,000		343
4,200		348
4,400		354
4,600		357
4,800		359
5,200		356
5,400		351
5,700		331
6,000		322
6,200		313
6,271		309

Lanipuna #1/Sidetrack - Survey #26

July 22, 1983, Friday

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
3,600		>320
4,000		332
4,200		342
4,400		346
4,600		350
4,800		350
5,200		349
5,400		344
5,700		325
6,000		314
6,200		308
6,271		305

Lanipuna #1/Sidetrack - Survey #27

July 30, 1983, Saturday, 8:45 a.m.

Kuster

Measured Depth, feet	True Vertical Depth, feet	Temperature, °F*
3,600	3,600	332
4,000	4,000	340
4,216	4,200	345
4,432	4,400	350
4,648	4,600	352
4,864	4,800	354
5,296	5,200	352
5,512	5,400	349
5,836	5,700	324
6,160	6,000	312
6,376	6,200	307
6,453	6,271	307

GeothermEx, Inc.
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5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804

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CABLE ADDRESS GEOTHERMEX
TELEX 66-31372 WRLD UW

APPENDIX C

Daily Drilling Report,

Lanipuna #1/Sidetrack

DAILY DRILLING REPORT

Lanipuna #1/Sidetrack

Date	Time	Day	Summary of Operations
5-11-83	0800	1	rig up on location
5-12-83	0800	2	run gyro survey/run in hole to cut casing
5-13-83	0800	3	cut 7-inch casing at 5,035 feet; pull out of hole with 7-inch casing and lay it down
5-14-83	0800	4	set cement plug at 3,763 feet, wait on cement, run in hole and bump plug at 3,794 feet, wait on cement
5-15-83	0800	5	wait on cement
5-16-83	0800	6	service rig, wait on cement
5-17-83	0800	7	0800-0900 service rig 0900-1030 cut drilling line, run in hole 1030-1330 tag cement at 3,495 feet 1330-1600 circulate hole 1600-1930 test BOP--600 lbs on pipe rams (15 minutes), 600 lbs on hydril (15 minutes) 1930-2130 drill cement 3,495-3,570 feet 2130-0800 mud up
5-18-83	0800	8	0800-1600 circulate hole, pick up dynadrill, one monel collar and 8-3/4-inch bit 1600-1700 run in hole 1700-1830 rig up and run directional survey 1830-2400 dyna drilling 2400-0530 dyna drilling, 3,575-3,595 feet 0530-0630 survey 0630-0800 dyna drilling
5-19-83	0800	9	0800-0830 service rig 0830-0930 dyna drilling 0930-1130 strap out of hole 1130-1553 make up new drilling assembly and run in hole circulate and check dyna drill 1553-1730 directional survey 1730-1840 dyna drill 1840-1945 survey 1945-2215 dyna drill

Date	Time	Day	Summary of Operations
			2215-2315 survey 2315-0200 dyna drill 0200-0300 survey 0330-0800 pull out of hole and repair chain on draw works
5-20-83	0800	10	0800-0900 repair draw works 0900-1030 pull out of hole and lay down dyna drill 1030-1600 run in hole with new bit 1600-1730 ream hole, 3,622-3,688 feet 1730-2030 drilling 8-3/4-inch hole 2030-2130 survey 2130-2400 drill 8-3/4-inch hole 2400-0800 drilling
5-21-83	0800	11	0800-0830 service rig 0830-0930 drilling 8-3/4-inch 0930-1045 directional survey 1045-1630 drilling 1630-2400 pull out of hole; break bit, dress stabilizer and pick up monel 2400-0030 run in hole 0030-0230 surveys at 3,700, 3800 and 3,900 feet 0230-0300 drilling 8-3/4-inch hole 0300-0800 trip out for weekend, rig up to run temperature survey
5-24-83	0800	12	0800-0830 service rig 0830-0900 temperature survey 0900-1230 replace draw works chain 1230-1500 run in hole 1500-2230 drilling 8-3/4-inch hole 2230-2315 directional survey 2315-2400 pull out of hole 2400-0230 pull out of hole 0230-0330 pick up dyna drill 0330-0800 test dyna drill and run in hole
5-25-83	0800	13	0800-0830 service rig 0830-0900 directional survey 0900-0930 drilling with dyna drill 0930-1000 directional survey 1000-1200 dyna drilling 1200-1230 directional survey 1230-2030 dyna drilling and surveys 2030-0200 pull out of hole and lay down dyna drill 0200-0300 makeup drilling assembly 0300-0800 run in and ream hole

Date	Time	Day	Summary of Operations
5-26-83	0800	14	0800-0830 service rig 0830-1300 ream in hole and drill 1300-1400 directional survey 1400-1730 drilling 1730-1800 directional survey 1800-2100 pull out of hole and lay down stabilizers 2100-2230 pick up dyna drill 2230-0100 run in hole 0100-0800 dyna drilling and surveys
5-27-83	0800	15	0800-1430 dyna drilling and survey 1430-1700 pull out of hole 1700-1930 run in hole 1930-0430 dyna drilling and surveys 0430-0800 pull out of hole and lay down dyna drill
5-28-83	0800	16	0800-0830 rig service 0830-1030 pick up 8-3/4-inch bit and two stabilizers and 16 collars with monel, run in hole 1030-1430 cut drilling line 1430-1600 run in hole 1600-1900 ream from 4,176-4,339 feet 1900-2000 survey 2000-2400 drill 8-3/4-inch hole, 4,339-4,375 feet 2400-0400 drilling 0400-0430 survey 0430-0630 drilling to 4,451 feet 0630-0800 pull out of hole to 2,987.24 feet
6-1-83	0800	17	0800-0900 start up and service rig 0900-1100 pull out of hole 1100-1230 pick up bit and dress stabilizer 1230-1400 run in hole 1400-1800 run in hole to 3,500 feet, circulate hole, run in hole to 4,451 feet 1800-2400 drilling 8-3/4-inch hole, 4,451-4,511 feet 2400-0330 drilling 8-3/4-inch hole 0330-0500 directional survey 0500-0800 drilling 8-3/4-inch hole
6-2-83	0800	18	0800-0830 service rig 0830-1000 drilling 8-3/4-inch hole 1000-1100 circulate and directional survey (4,600 feet: 20°45', N14E) 1100-1900 drilling 1900-2000 directional survey (4,696 feet: 20°25', N14E) 2000-0400 drilling 0400-0530 directional survey (4,790 feet: 20°45', N19E) 0530-0800 pull out of hole

Date	Time	Day	Summary of Operations
6-3-83	0800	19	0800-0930 pull out of hole 0930-1000 service rig 1000-1400 dress near bit stabilizer and move string stabilizer up one collar, run in hole 1400-1600 drilling 8-3/4-inch hole 1600-2400 drilling 8-3/4-inch hole (4,857-4,914 feet) 2400-0030 drilling 0030-0130 direction survey (4,883 feet: 22°, NE20) 0130-0800 drilling 8-3/4-inch hole
6-6-83	0800	20	0800-0830 service rig 0830-1230 drilling 8-3/4-inch hole and surveys 1230-1600 pull out of hole, dress stabilizer 1600-1945 run in hole 1945-2400 drilling 8-3/4-inch hole 2400-0130 drilling 8-3/4-inch hole 0130-0200 circulate hole 0200-0300 directional survey 0300-0800 pull out of hole and rig to run temperature survey
6-7-83	0800	21	0800-0830 service rig; set pumphouse off of #1 pump engines 0830-1030 temperature survey 1030-1600 dress stabilizer and run in hole 1600-1700 ream to bottom and circulate 1700-1800 directional survey at 5,070 feet: 26° deviation 1800-2400 drilling 8-3/4-inch hole, 5,078-5,136 feet 2400-0700 drilling 8-3/4-inch hole, 5,136-5,203 feet 0700-0800 directional survey at 5,163 feet: 25°30'
6-8-83	0800	22	0800-0830 service rig 0830-0900 directional survey at 5,163 feet: 25°30', N20E 0900-1600 drilling, 5,203-5,287 feet 1600-1630 drilling 8-3/4-inch hole 1630-1715 survey 1715-0300 drilling 8-3/4-inch hole 0300-0400 directional survey at 5,351 feet: 24°15', N21E 0400-0800 pull out of hole

Date	Time	Day	Summary of Operations
6-9-83	0800	23	0800-0830 service rig 0830-0930 pull out of hole and rig to log 0930-1030 run temperature survey and clean 2 pits 1030-1330 cut drilling line 1330-1600 dress rear bit stabilizer, run in hole 1600-2000 run in hole, ream from 5,359-5,391 feet 2000-2400 drilling 8-3/4-inch hole, 5,391-5,428 feet 2400-0500 drilling 8-3/4-inch hole 0500-0615 directional survey 0615-0800 drilling 8-3/4-inch hole
6-10-83	0800	24	0800-0830 service rig 0830-1430 drilling 8-3/4-inch hole 1430-1530 circulate and survey at 5,537 feet: 23°45' 1530-1600 drilling 8-3/4-inch hole 1600-2400 drilling 8-3/4-inch hole, 5,583-5,692 feet 2400-0030 drilling 8-3/4-inch hole 0030-0100 circulate and survey at 5,563 feet 0100-0800 drilling 8-3/4-inch hole
6-11-83	0800	25	0800-0830 service rig 0830-1030 drilling 8-3/4-inch hole 1030-1200 circulate and survey at 5,827 feet 1200-2300 drilling 8-3/4-inch hole 2300-2400 survey at 5,913 feet 2400-0030 survey at 5,913 feet: 24° 0030-0130 drilling 8-3/4-inch hole 0130-0230 circulating 0230-0730 pull out of hole 0730-0830 rig for temperature survey
6-14-83	0800	26	0300-0800 temperature surveys
6-15-83	0800	27	0800-0830 service rig 0830-1130 temperature survey 1130-1600 run in hole (picking 24 new hard banded drill pipe), stop at 3,500 feet to fill drill pipe, stop at 5,000 feet and circulate bottoms up 1600-1700 run in hole to 5,913 feet, ream to 5,967 feet 1700-0800 drilling 8-3/4-inch hole

Date	Time	Day	Summary of Operations
6-16-83	0800	28	0800-0830 service rig 0830-1400 drilling 8-3/4-inch hole 1400-1500 circulate and survey at 6,878 feet 1500-1600 drilling 8-3/4-inch hole 1600-2400 drilling 8-3/4-inch hole, 6,083-6,154 feet 2400-0800 drilling 8-3/4-inch hole, 6,154-6,259 feet
6-17-83	0800	29	0800-0830 service rig 0830-0930 drilling 8-3/4-inch hole 0930-1500 circulate at 6,272 feet prior to pulling out of hole, survey and pull out of hole, lay down 10 joints drill pipe 1500-1600 rig up and run temperature survey 1600-1930 temperature surveys 1930-2400 make up tools and run in hole, lay down 12 joints hard band drill pipe with blue code, dress string stabilizer with 8-3/4-inch blades, near bit stabilizer with 3/16-inch out 2400-0230 run in hole, circulate 0230-0800 break in new bit and drill
6-18-83	0800	30	0800-0830 service rig 0830-1400 drilling 8-3/4-inch hole, 6,300-6,395 feet 1400-2400 drilling 8-3/4-inch hole, 6,395-6,443 feet 2400-0500 drilling 8-3/4-inch hole, 6,443-6,465 feet 0500-0600 circulate 40 feet off bottom 0600-0800 pull out of hole
6-21-83	0800	31	Run in hole and displace mud with water, circulate at total depth for 1-1/2 hours, pull out of hole at 0800